EXPRESS MAIL NO.: EK028875327US

IN THE UNITED STATES PATENT AND TRADEMARK

Assistant Commissioner for Patents
Washington, D.C. 20231

Attorney's Docket No.: 14013-33US.

FILING TRANSMITTAL

Transmitted herewith for filing is the Patent Application of: John Dung-Quang Ly

For: "DIAGNOSTIC/REMOTE MONITORING BY EMAIL"

ENCLOSURES

☒ 20 page application including specification, claims and abstract;
☒ 06 sheets, Figs. 1-6 of informal drawings;
☒ a Declaration, Power of Attorney & Petition (signed)(2 pages);
☒ a postcard for return to us as proof of receipt of the above documents.
and
☒ an executed Assignment of the invention with a Recordation form cover sheet;
☐ Verified Statement Claiming Small Entity Status (37 CFR 1.9(f) and 1.27(b))
☐ IDS (form PTO-1449) and copies of references;
☐ an associate power of attorney;
☐ a certified copy of the priority document (Under 35 USC 119) is enclosed
☐ Other

TYPE OF FILING

☐ This application claims the benefit of _____ Application Serial No. _____
Filed _____ . (35 USC 120).
☐ This application claims the benefit of the priority date of an earlier filed _____
application (35 USC 119).
☐ This is an application filed pursuant to 37 CFR 1.53, permitting receipt of a filing date
upon filing of specification, claims and drawings, if required, with applicant being given a
period of one month from the date of notice to file the fee and oath or declaration.
☒ In the event any parts of this application are missing, please treat this as a filing under
37 CFR 1.53 as defined just above.

CERTIFICATE OF MAILING (37 CFR 1.10(a))
CERTIFICATE OF MAILING BY "EXPRESS MAIL" - Rule 10: I hereby certify that this correspondence is being deposited with the U. S. Postal Service "Express Mail Post Office to Addressee" Service under 37 CFR 1.10 as Express Mail No. EK028875327US addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231 on March 7, 2000 by Gail Simmons.

FEE CALCULATION

The filing fee has been calculated as shown below:

			SMALL ENTITY		OR	OTHER THAN A SMALL ENTITY	
BASIC FEE Design Patent			$155	$		$310	$
BASIC FEE Utility Patent			$345	$		$690	$690
EXTRA FEES			RATE	FEE		RATE	FEE
Total claims	25	minus 20 =	x9 =	$	5	x18 =	$90
Independent Claims	04	minus 3 =	x39=	$	1	x78 =	$78
☐ Multiple Dep. Claim			+130 =	$		+260 =	$
☒ Assignment			+40 =	$		+40 =	$40
☐ Rule 53 Surcharge			+65 =	$		+130 =	$
TOTAL				$			$898

FEE PAYMENT

☒ Attached is a check in the amount of $898.00 to cover the filing fees.

☐ Please charge Account No. _____ the sum of $AMOUNT

FEE DEFICIENCY

☐ Please charge Account No. _____ in the sum of $AMOUNT

☐ The Commissioner is authorized to charge (or credit any overpayment) to deposit account No. _____ :

    ☐ Any additional filing fees required under 37 CFR 1.16, except Rule 53 filings, which will be paid within the time permitted by PTOL 1533.

    ☐ Assignment Recordal fees.

☐ The filing fee and surcharge under 37 CFR 1.16, patent application processing fees under 37 CFR 1.17 and patent issue fees under 37 CFR 1.18 are intended to be paid by our firm as they arise. As no abandonment is intended by any inadvertent nonpayment of fees, the Commissioner is hereby authorized to charge payment of such fees as from time to time come due, if not paid prior to due date to our Deposit Account No._____ .

☐ A duplicate copy of this sheet is enclosed.

Dated: March 7, 2000

Respectfully submitted,

Maryam Imam
Reg. No: 38,190

Law Offices of IMAM & ASSOCIATES
Two North Second St., Suite 1100
San Jose, CA 95113
Tel.: (408) 271-8752
Fax: (408)-271-8727

Specification

DIAGNOSTIC/REMOTE MONITORING BY EMAIL

5 ## BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates generally to a method and apparatus for detecting a problem with a network device employed in a communication system and particularly to a

10 method and apparatus for detecting a hardware or software-related problem within one or more network device among a large number of operational network devices within the communication system.

Description of the Prior Art

In modern communication systems, there may be a large number of network devices

15 such as mail servers, routers and computers present within a system. Under such circumstances, it is common to have equipment failure, which would then require diagnostic evaluation and debugging. If the system includes hundreds of routers, such as in Cisco Systems Inc. laboratories, in order to identify the router that has failed, an engineer located at a technical support center must establish at least limited communication with every one of the

20 routers (referred to as logging into the routers), of the large number of routers, in order to try to narrow the problem to one or more specific routers prior to diagnosis of the problem. This is commonly a considerably time-consuming and rigorous process. In fact, currently, among tens and hundreds of routers in operation, it is not unusual for engineers to spend one month in detecting a problem with a specific router.

25 Currently, when a component within a router fails, the router generates error messages for notification of the failure.

There are several ways in which a network communication system may fail. Among these are problems arising in the hardware and software components of various devices and communication lines and interfaces connecting the various devices of the communication

30 system together. When there is a hardware problem, such as the failure of a board in one of the devices due to overheating, the driver in the device detects the problem by receiving an

error message from the board thereby alerting the software that is being executed in the device of the device's failure. However, when the system fails, the valuable information regarding the reason for failure, which may be embedded in an error message in the software, may be lost, making the task of diagnosing the cause of failure more difficult and time-consuming by

5   erasing any potential clues which might otherwise help an engineer in diagnosing the problem.

By way of execution of the software in a device, relevant information regarding the failure of the device exists but it is not necessarily communicated to the technical support staff after the device has failed. When the device, which might be a computer or an access server

10   (router), is powered down and then powered back on, the original problem may disappear during rebooting or the conditions, which caused the problem, may no longer exist. Such is the case when a board malfunctions due to overheating and resumes functioning properly once it is cooled. Similarly, an existing problem may not recur immediately after the device is rebooted and may resurface at a later time making the task of troubleshooting (or

15   debugging) more difficult.

Before the occurrence of the failure of the device, the operating system residing and being executed in the device or the software being executed on the device has the most current information regarding the status of various components in the device. Currently, such information is not communicated to the technical support center and remains isolated within

20   the device. The engineers located at a technical support center, based on the status of the device immediately before its failure, could draw valuable insights into the mechanisms of failure and suggest ways of remedying the problem.

If the device is a computer, the operating system or the software within the computer has current information regarding the status of the modem, software updates, status of the

25   hard drive and every other hardware and software subcomponent within the computer. If such information were available to the technical support center, troubleshooting the device could be performed much more efficiently and cost effectively. In addition, since the time duration in which the system is out of service is shortened, the customers making use of the system experience less delay, resulting in a higher degree of customer satisfaction.

30   Therefore it is desirable to devise a system and method for monitoring the status of a network device at all times and for reporting any problems that may arise in the hardware,

software or the interface components of the device to a technical support center so as to rapidly detect a problem with one or more network devices within a large group of network devices. Additionally, the need arises for the monitoring system and method to include the capability to process instructions from the technical support center in order to execute

5 diagnostic tests on the hardware components or request more detailed information from the software subsystems included within the device.

SUMMARY OF THE INVENTION

Briefly, in an embodiment of the present invention, a network device is disclosed for use in a communication system having a technical support center operated by a technical

10 support staff, the technical support center being in communication with the network device through a packet switching network. The network device includes one or more hardware subsystems, one or more software subsystems and means for monitoring the status of the hardware and software subsystems so that when a problem occurs with respect to one or more of the hardware and software subsystems of the network device, the network device for

15 transmitting a first message to the technical support center to notify the technical support center of the problem, wherein the technical support staff is able to diagnose the problem without interruption to the operation of the network device.

The foregoing and other objects, features and advantages of the present invention will be apparent from the following detailed description of the preferred embodiments which make

20 reference to several figures of the drawing.

IN THE DRAWING

Fig. 1 shows a high-level block diagram of a communications system with the network device assembly and technical support center.

25 Fig. 2 depicts a high-level block diagram of a network device including embedded software.

Fig. 3 illustrates the technical support center of Fig. 1 including central process software.

Fig. 4 depicts an example of a computer register carrying an error message due to

30 hardware or software failure.

14013-33US 3

Fig. 5 shows a high-level block diagram of the sequence of steps used in sending an email from a network device to an Internet Protocol network.

Fig. 6 shows a flow chart of the sequence of steps executed for receiving commands from the technical support center and responding thereto.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

5

Referring now to Fig. 1, a communication system 10 is shown to include a network device assembly 12, a packet switching network 18 and a technical support center 22 for use by technical support staff 23 in accordance with an embodiment of the present invention. The network device assembly 12 comprises numerous network devices 14, which may be various

10 types of network devices such as network access servers, routers, computer, etc. The network device assembly 12 may include a large number of network devices. A typical application includes hundreds of routers, each of which is an AS5800 model manufactured by Cisco Systems, Inc. of San Jose, California.

In one embodiment of the present invention, the packet switching network 18 may be

15 an Internet Protocol (IP) network, such as the Internet. The technical support center 22 is a center equipped with computers and diagnostic equipment typically located at a laboratory site.

Each of the network devices 14 is coupled to the packet switching network 18 through an interface line 16. The packet switching network 18 is coupled to the technical support

20 center 22 through an interface line 20. According to one embodiment of the present invention, there are two sets of software programs. The first set of software programs, which will be referred to as the embedded software throughout this document, resides in each of the network devices 14 which may be a router or a computer or any other network device used by a client (or user). The second set of software programs, referred to as the central process

25 software throughout this document, resides in the technical support center 22.

Each of the network devices 14 is in communication with the technical support center 22 through the packet switching network 18. When there are a large number of network devices within the assembly 12, it is likely that a network device may fail due to a hardware or software-related problem.

30 According to one embodiment of the present invention as shown in Fig. 1, the embedded software resides in every network device 14. The embedded software monitors the

14013-33US   4

status of every hardware component and every software subsystem of the network device 14 by collecting and analyzing data received from the hardware components and software subsystems thereof. When a problem with either a software or a hardware component of the network device 14 is detected by the embedded software, the embedded software notifies the

5 technical support center 22 regarding the problem by transmitting an email message 20, through the interface 16, thereto. Each network device 14 includes the embedded software, accordingly, the technical support center 22 is notified of any problem that may arise within the network device assembly 12.

Alternatively, the network device assembly 12 comprises a number of computers each

10 of which is connected to the technical support center 22 through the network 18. According to an embodiment of the present invention as shown in Fig. 1, the embedded software resides in each of the computers in the network device assembly 12 and monitors the status of various components and processes of the computer such as modems, software updates, hard drive, memory, and the like. When a problem within any hardware component or software

15 subsystem of the computer develops, whether the problem leads to the failure of the computer or not, the embedded software detects the problem and notifies the technical support center 22 by sending an email message, such as the message 20, to the technical support center 22.

The technical support center 22 behaves essentially as an email server with a large database for storing email messages. In addition and as will be discussed in further detail

20 relative to other figures of this patent document, the technical support center 22 carries the central process software, which facilitates communications between the network device 14 and the technical support center 22. In particular, when a problem in the network device 14 is reported to the technical support center 22, the technical support staff 23, i.e. engineers, at the technical support center 22 may need more information to determine the cause of the problem

25 than what is initially conveyed to them in the email message that was sent from one or more of the network devices 14 to the technical support center 22. Thus, in one embodiment of the present invention, using the central process software, the technical support staff 23 send an email message 21 back to the network device 14 requesting more information regarding the problem. The email message 21 is optional in that no further information regarding the

30 problem may be needed and/or solicited.

In the case where detail information regarding the problem is requested, as an example, the email message 20 transmitted to the technical support center 22 may only indicate that a board in a hardware component of the network device 14 is experiencing a problem. The technical support center 22 may require additional diagnostic tests to be

5   performed on the problematic board prior to determining the cause of the problem. Using the central process software, the technical staff 23 at the technical support center 22 perform diagnostic tests on the defective board through the embedded software of the network device 14. To elaborate, if the network device 14 is a computer, the user continues to interact with the computer without any interruption while the diagnostic tests are being performed in the

10   background by the computer. This clearly offers considerable advantage to the user.

Accordingly, the use of the embedded software and the central process software facilitate communications between the network assembly 12 and the technical support center 22 for diagnostics and remote monitoring of each of the plurality of network devices 14. In accordance with another embodiment of the present invention, the technical support center 22

15   does not include the central process software and only the embedded software is used in each of the network devices 14 in order to monitor the status of the latter and report any problems associated therewith to the technical support center 22. Under such circumstances, the email message 21 is not sent and consequently not as much information can be requested from the embedded software by the technical support center 22 as is the case when the latter includes

20   the central process software. Accordingly, less detailed information is available to the technical support center 22 for diagnostic purposes; nevertheless it is possible to perform diagnostic and remote monitoring of each of the network device 14.

Referring now to Fig. 2, one of the network devices 14 of Fig. 1 is shown to be coupled to the network 18 through the interface 16 according to an embodiment of the present

25   invention. The embedded software 25 is shown, in Fig. 2, to reside within the network device 14. The embedded software comprises several software subsystems, i.e. a memory monitoring subsystem 26, an email/page subsystem 24, a remote diagnostic embedded process subsystem 28, a software health status monitor subsystem 30 and a hardware health status monitor subsystem 32. In addition, the network device 14 includes a plurality of other

30   software subsystems 36 and a plurality of hardware devices 34. Examples of the other software subsystems 36 are the Netscape browser application program, Microsoft Excel

14013-33US   6

application program, and the like. Examples of hardware devices 34 are a graphics display board, a hard drive, a modem, and the like.

The remote diagnostic embedded process subsystem 28 is in communication with the other components of the embedded software subsystems. More specifically, the remote diagnostic embedded process subsystem 28 is in communication with the memory monitoring subsystem 26, the email/page subsystem 24, the hardware health status monitor subsystem 32 and the software health status monitor subsystem 30 through the software interfaces 40, 38, 42 and 44, respectively. Moreover, the software health status monitor subsystem 30 is coupled to the other software subsystems 36 through the software interface 48 and the hardware health status monitor subsystem 32 is coupled to the hardware devices 34 through the software interface 46.

The hardware health status monitor subsystem 32 monitors the status of the hardware devices 34 within the network device 14 and communicates such status information to the remote diagnostic embedded process subsystem 28. The hardware health status monitor system 32 further performs background diagnostic tests on the hardware devices 34 as requested by the technical support center 22 (shown in Fig. 1). The software health status monitor subsystem 30 monitors the status of the software subsystems 36 within the network device 14 and communicates such status information to the remote diagnostic embedded process subsystem 28.

The remote diagnostic embedded process subsystem 28 is the main software subsystem of the embedded software. It is used to collect and analyze all of the information provided by the software health status monitor subsystem 30 and the hardware health status monitor subsystem 32. During analysis of the status information, the remote diagnostic embedded process subsystem 28 detects problems encountered by the other software subsystems 36 or the hardware devices 34 resident within the network device 14. In the event a problem develops within any of the software subsystems or hardware devices of the network device 14, the remote diagnostic embedded process subsystem 28 alerts the technical support center 22 by sending information regarding the software or hardware problem thereto.

Transmittal of information from the remote diagnostic embedded process subsystem 28 to the technical support center 22 is accomplished through the email/page subsystem 24. The latter constructs an email message (such as the email message 21 in Fig. 1) incorporating

7

the information received from the remote diagnostic embedded process subsystem 28 through the software interface 38 and transmits the email message, through the network 18, to the technical support center 22 (shown in Fig. 1). The email/page subsystem 24 can alternatively send an email or a facsimile message or alternatively page a user of the network device 14 in
5   order to alert the user of the problem.

As an example, if the network device 14 is a computer whose Internet connection fails, the user has no way of knowing initially whether the Internet line or some component of the modem board has failed. In Fig. 2, the modem board would be one of the devices in the hardware devices 34. The remote diagnostic embedded process subsystem 28 will know of
10   the status of the modem board immediately before the failure of the Internet connection and thus will transmit this information to the technical support center 22. The engineers at the technical support center 22 then detect the problem(s) associated with the modem board based upon status information regarding the modem board, which would have been received by the remote diagnostic embedded process subsystem 28 immediately before the connection failure.

15   If there are no problems with the modem board, a determination is made as to the failure of the Internet line to be properly connected. In this case, information regarding the failed Internet line is sent to memory, such as non-volatile random access memory (NVRAM) or flash memory for subsequent retrieval thereof by the network device when the latter is again operational. Alternatively, an alarm, in the form of a light indicator or otherwise, is set
20   by the network device indicating a problem with the latter. On the other hand, if the problem emanates from the modem board, the technical support center 22 may decide to perform diagnostic tests on the board, in which case the center 22 will instruct the remote diagnostic embedded process 28 as to how to perform the diagnostic tests.

Memory monitoring subsystem 26 is another software subsystem of the embedded
25   software for monitoring the memory of the network device 14. In the case where the network device 14 is a computer, the memory monitoring subsystem 26 determines if the present memory offers adequate capacity for proper performance of the computer or if the memory is in need of upgrading. In addition, the memory monitoring subsystem 26 checks for memory leaks and memory corruption. Memory leaks occur when memory that is assigned for the
30   performance of tasks becomes less and less over time resulting in at least the appearance of insufficient memory capacity and memory corruption is defective areas of the memory, which

14013-33US   8

may result in insufficient memory capacity. If the user is working with a large program requiring more memory than is available in the computer, the memory monitoring subsystem 26 notifies the remote diagnostic embedded process subsystem 28 accordingly. The subsystem 28, in turn, notifies the user, through the email/page subsystem 24, regarding the

5   inadequacy of the current memory capacity of the computer.

According to one embodiment of the present invention, the technical support center 22 instructs the remote diagnostic embedded process 28 as to how to detect a potential problem. For instance, referring to our previous example, the engineers at the technical support center 22, i.e. technical support staff 23 in Fig. 1, may decide that interruption of the communication

10   line 16 more than five times in an hour presents a potential problem and warrants special attention. Accordingly, the technical support center 22 configures the remote diagnostic embedded process subsystem 28 through email to detect a problem and to notify the center 22 of the same if and when the communication line is interrupted more than five times in an hour.

15   In Fig. 2, while not shown, the network device 14 includes a processor such as a central processor unit (CPU) (or computer medium) and a storage area, a computer readable medium, for storing software programs for carrying out the various functions discussed herein. The processor executes code from the computer readable medium for effectuating the functions discussed herein.

20   Referring now to Fig. 3, the technical support center 22 is shown to be coupled to the network 18 through the interface 20 according to an embodiment of the present invention. The technical support center 22 is shown to comprise the email server 50, the command-formatter 54 and the user interface 58. The email server 50 communicates with the command-formatter 54 through a software interface 52 and the command-formatter 54

25   communicates with the user interface 58 through a software interface 56.

The email server 50 is a device for collecting the email messages originating from the network 18 and for transmitting the email messages originating from the user interface 58 to the network 18. An example of an email server is a Personal Computer (PC). The command-formatter 54 is a software program for translating the email messages originating from the

30   network device 14 into a format which is easily understandable by the technical staff and engineers at the user interface 58 and vice versa. While the command-formatter 54 in the

14013-33US   9

embodiment of Fig. 3 is a software program, the functions performed thereby may be implemented in a hardware structure without departing from the scope and spirit of the present invention. The user interface 58 provides a graphical representation for communicating information between the technical staff and engineers and the network device

5   14 through the command-formatter 54, the email server 50 and the network 18.

In addition, the command-formatter 54 has the capability to format commands when the engineers decide to request the remote diagnostic embedded process 28 to perform specific tasks. For instance if the remote diagnostic embedded process 28 is asked to report the modem board status every hour, perform diagnostic test on a modem when the modem

10   experiences three consecutive connecting failures and report peak central processing unit (CPU) loading every three hours, an email message is sent from the user interface 58 to the remote diagnostic embedded process 28 as follows:

REPORT: modem_board_status INTERVAL: 60

RUN: modem_modem_diagnostic WHEN: 3_consecutive_fail

15   REPORT: cpu_load INTERVAL: 180

Consequently, the command format 54 allows the engineers to communicate with the network device 14 without the need to learn a special syntax.

In one embodiment of the present invention it is not necessary to include the user interface 58 and the command-formatter 54 within the technical support center 22. In such a

20   case, the technical support center 22 only includes the email server 50 for receiving and transmitting email messages to and from the technical support center 22. However, engineers no longer can instruct the remote diagnostic embedded process 28 to perform specific tasks in order to facilitate the diagnostic testing and remote monitoring of the network device 14. Nevertheless, it is still possible to carry out diagnostics and remote monitoring of the network

25   device 14 using only the email server 50.

Sometimes a problem in the hardware or software components of the network device 14 which has interrupted the normal operation of the network device 14 may disappear upon rebooting of the network device. To make matters worse, the problem may not occur for some time thus making recreating the problem for diagnostic purposes difficult. The problem

30   may have its origins in a number of sources such as the hard drive, the memory, the power supply, etc. One of the advantages of the present invention, as shown in Fig. 2, is that the

remote diagnostic embedded process 28 receives information concerning the status of every software and hardware component immediately before the failure of the network device 14 either from the software health status monitor subsystem 30 or from the hardware health status monitor subsystem 32. The status information may then be used by the technical
5   support center 22 to identify the source of the problem.

For the case when the network device 14 is a computer, an example of the status information is shown in Fig. 4. Fig. 4 shows the status of a number of hardware and software components in the computer and is referred to as a computer register. The computer register indicates the status of various components immediately before the computer failed due to a
10   problem in one of its hardware or software components. The computer register shown in Fig. 4 includes error messages, which emanated from the faulty hardware/software component immediately before the failure of the faulty component. In Fig. 4, an error block 60 is shown to include three codes. As would be obvious to one of the engineers of a network device who would have designated such codes, the codes in the error block 60 indicate a problem within
15   one of the subsystems of the computer. For example, a faulty board in the hard drive of the computer could have generated the codes in the error block 60. A trained engineer could identify the subsystem that has failed by viewing the codes in the error block 60.

The computer register in Fig. 4 is compiled by the hardware health status monitor subsystem 32 and transmitted to the remote diagnostic embedded process subsystem 28.
20   After having recognized that the computer register includes an error message, the remote diagnostic embedded process 28 transmits the computer register to the technical support center 22 via the email/page subsystem 24. The engineers in the technical support center 22 detect the problem by observing the codes in the error block 60 and transmit an email message back to the remote diagnostic embedded process subsystem 28 and the subsystem 28
25   implements diagnostic instructions accordingly.

There are several criteria used by the remote diagnostic embedded process subsystem 28 that need to be met in order for the latter to notify the technical support center 22 of potential problems within the network device 14. One such criterion is met when an error message is detected by the remote diagnostic embedded process subsystem 28 as shown in
30   Fig. 4. There are other criteria, besides detection of an error message, that are configurable, i.e., the technical support center 22 may alter these criteria by reconfiguring the remote

14013-33US   11

diagnostic embedded process subsystem 28. Listed below are some of the criteria that need to be met before a message is forwarded to the technical support center 22.

1. Low memory (both shared or main memory)

2. High percentage of call failures on a modem or a trunk line

3. Detection of an error message

4. Detection of software reload due to software failure

5. Detection of a failed line or interface (i.e. a T1 line going down)

6. Detection of hardware problems (i.e. a board is shutdown due to a high temperature problem)

7. User defined interval (i.e. memory leak, CPU utilization, etc.)

8. Quality of an interface (i.e. high collision on Fast Ethernet)

Fig. 5 shows a block diagram outlining an example of the sequence of steps taken in sending an email message from the network device 14 to the network 18. In the example of Fig. 5, information regarding the status of three software subsystems is gathered by the software health status monitor subsystem at step 76. The three software subsystems are shown as software subsystem A, B through N. Examples of such software subsystems are an IP protocol, a user interface and a Netscape browser program. For instance, the software subsystem A in the example of Fig. 5 is an IP protocol, the software subsystem B is a user interface and the software subsystem N is a Netscape browser program. While three software subsystems are shown in Fig. 5, there may be more or less than three software subsystems employed. Information regarding the status of the software subsystems A, B and N is gathered at steps 62, 64 and 66, respectively, by the software health status monitor subsystem at step 76.

In Fig. 5, information regarding the status of hardware subsystems is gathered by the hardware health status monitor subsystem at step 74. The hardware subsystems are referred to as device driver A 68, device driver B 70 and device driver N 72. As in the case of software subsystems, more or less than three hardware subsystems, or device drivers, may be employed without departing from the scope and spirit of the present invention. The device drivers 68 – 72 may be different types of hardware structures. As an example, the device driver A 68 is shown to be an Ethernet device, the device driver B 70 is shown to be a hard disk controller device and the device driver N 72 is shown to be a modem device in Fig. 5.

14013-33US

12

Next, information from the hardware health status monitor subsystem, the software health status monitor subsystem and the memory monitor subsystem, at step 78, is forwarded to the remote diagnostic embedded process subsystem where it is collected, combined and updated at step 80.

5 Based on the information compiled at the remote diagnostic embedded process subsystem 28, the status of the network device, (referred to, as the "system" in Fig. 5) is determined at step 82. Subsequently, at step 84, a determination is made as to whether or not the technical support center 22 should be notified regarding the status of the system. If there is no problem with the system there is no need to notify the technical support center 22 and the

10 process of collecting information again continues from step 80. However, if there is a problem in the system as indicated, for example, by an error message in the computer register shown in Fig. 4, then a notification is transmitted, as indicated at step 86. The notification is formatted as either an email message or a fax or a page and is transmitted through the email/page subsystem at step 88 to the network 90.

15 Fig. 6 shows a flow diagram of the sequence of steps taken in receiving commands from the technical support center 22 and responding thereto. Initially commands originating in the technical support center 22 are received through the packet switching network 92 by the email/page subsystem 94. The commands are then parsed and interpreted at step 96 and stored in the remote diagnostic embedded process subsystem, as shown at step 98. There are

20 several types of actions that may be taken in response to the commands indicated at step 100. The first type of action is to prepare a report of the status of the network device and send the report back to the network as shown at step 102. Subsequently, the report is formatted as an email message, fax or a page at step 126 and sent to the email/page subsystem at step 128. The email/page subsystem then transmits the information in the report through the packet

25 switching network 130.

The second kind of action is to send a command to a software subsystem at step 104 in order to perform diagnostic tests. The command is implemented on three software subsystems shown at steps 108, 110 and 112. The result of the diagnostic testing is compiled in the software health status monitor subsystem at step 122. The last kind of action taken by

30 the remote diagnostic embedded software is to send a command to a hardware subsystem as indicated at step 106 for purposes of diagnostics. The command is implemented on three

14013-33US   13

hardware subsystems 114, 116 and 118. The result of the diagnostic tests is compiled in the hardware health status monitor subsystem at step 120. Information regarding the status of the system as gathered by the software health status monitor subsystem and the hardware health status monitor subsystem is collected and combined together at step 124. The status

5   information is then formatted into an email message or a fax or a page at step 126 and transmitted via the email/page subsystem at step 128 to the network 130.

Although the present invention has been described in terms of specific embodiments it is anticipated that alterations and modifications thereof will no doubt become apparent to those skilled in the art. It is therefore intended that the following claims be interpreted as

10   covering all such alterations and modification as fall within the true spirit and scope of the invention.

What is claimed is:

14013-33US   14

CLAIMS

1   1.   A network device assembly employed in a communication system comprising:

2   a plurality of network devices able to communicate network information

3   through a packet switching to a technical support center operated by technical support

4   staff, each of the plurality of network devices including one or more hardware subsystems

5   and one or more software subsystems and for monitoring the status of the hardware and

6   software subsystems included therein so that when a problem occurs with respect to one

7   or more of the hardware and software subsystems of a particular one of the plurality of the

8   network devices, the particular network device sends a first message to the technical

9   support center notifying the technical support center of the problem.

1   2.   A network device assembly as recited in claim 1 wherein the first message is in the

2   form of an email message.

1   3.   A network device assembly as recited in claim 1 wherein the first message is in the

2   form of a fax transmission.

1   4.   A network device assembly as recited in claim 1 wherein the first message is in the

2   form of a page.

1   5.   A network device assembly as recited in claim 1 including a processor for executing

2   embedded software for monitoring the status of the hardware and software subsystems.

1   6.   A network device assembly as recited in claim 1 wherein the packet switching

2   network is the Internet.

1   7.   A network device assembly as recited in claim 1 including a computer register for

2   indicating the status of the hardware and software subsystems immediately before the

3   problem.

1 8.   A network device assembly as recited in claim 7 wherein the computer register

2 includes error messages for identifying a particular hardware or software subsystem failure.

1 9.   A network device assembly as recited in claim 1 wherein each of the plurality of

2 network devices includes a remote diagnostic embedded process subsystem, a hardware

3 health status monitor subsystem and a software health status monitor subsystem, the remote

4 diagnostic embedded process subsystem for communicating with the hardware health status

5 monitor subsystem and a software health status monitor subsystem and for collecting status

6 information provided by the software health status monitor subsystem and the hardware

7 health status monitor subsystem and for detecting problems encountered by the hardware and

8 software subsystems.

1 10.   A network device assembly as recited in claim 1 wherein the plurality of network

2 devices is responsive to a second message generated by the technical support center for

3 requesting further information regarding the problem.

1 11.   A network device assembly as recited in claim 1 wherein at least one of the plurality

2 of network devices is an access server.

1 12.   A network device for use in communication with a technical support center operated

2 by a technical support staff, the technical support center being in communication with the

3 network device through a packet switching network, comprising:

4   one or more hardware subsystems;

5   one or more software subsystems; and

6   means for monitoring the status of the hardware and software subsystems so

7 that when a problem occurs with respect to one or more of the hardware and software

8 subsystems of the network device, the network device transmits a first message to the

9 technical support center to notify the technical support center of the problem.

1 13.   A network device as recited in claim 12 wherein the technical support staff is able to

2 diagnose the problem without interruption to the operation of the network device.

14013-33US   16

1   14.   A network device as recited in claim 12 wherein the first message is in the form of an

2   email message.

1   15.   A network device as recited in claim 12 wherein the first message is in the form of a

2   fax transmission.

1   16.   A network device as recited in claim 12 wherein the first message is in the form of a

2   page.

1   17.   A network device as recited in claim 12 wherein the packet switching network is the

2   Internet.

1   18.   A network device assembly as recited in claim 12 wherein the network device is an

2   access server.

1   19.   A network device as recited in claim 12 including a remote diagnostic embedded

2   process subsystem, a hardware health status monitor subsystem and a software health status

3   monitor subsystem, the remote diagnostic embedded process subsystem for communicating

4   with the hardware health status monitor subsystem and a software health status monitor

5   subsystem and for collecting status information provided by the software health status

6   monitor subsystem and the hardware health status monitor subsystem and for detecting

7   problems encountered by the hardware and software subsystems.

1   20.   A network device as recited in claim 19 wherein the remote diagnostic embedded

2   process subsystem detects an error message prior to the transmission of the first message.

1   21.   A network device as recited in claim 20 wherein the remote diagnostic embedded

2   process subsystem detects certain criteria regarding the status of the network device prior to

3   the transmission of the first message.

1   22.   A network device as recited in claim 12 wherein the technical support center generates

2   a second message and sends the same to the network device for requesting further information

3   regarding the problem.

1   23.   A network device as recited in claim 12 wherein the network device is in

2   communication with a user and further wherein the technical support center includes an email

3   server coupled to a command-formatter for communicating with a user interface, the email

4   server for collecting the first message, the command-formatter for translating the first

5   message into a format that is understandable to the user and the user interface for displaying

6   information communicated between the network device and the user.

1   24.   A method for detecting a problem in a network device comprising:

2   during the operation of the network device, able to communicate network

3   information through a packet switching network to a technical support center being

4   operated by a technical support staff, the network device including one or more hardware

5   subsystems and one or more software subsystems, monitoring the status of the hardware

6   and software subsystems;

7   detecting the occurrence of a problem associated with one or more of the

8   hardware and software subsystems of the network device; and

9   sending a first message to the technical support center for notification of the

10 problem so that the technical support staff is able to diagnose the problem without

11 interruption to the operation of the network device.

1   25.   A computer readable medium having stored therein computer readable program code

2   comprising instructions for performing the following steps:

3   during the operation of a network device, able to communicate network

4   information through a packet switching network to a technical support center being

5   operated by a user, the network device including one or more hardware subsystems and

6   one or more software subsystems, monitoring the status of the hardware and software

7   subsystems;

8   detecting the occurrence of a problem associated with one or more of the

9   hardware and software subsystems of the network device; and

10   sending a first message to the technical support center for notification of the

11   problem so that the technical support staff is able to diagnose the problem without

12   interruption to the operation of the network device.

ABSTRACT

A network device for use in a communication system having a technical support center operated by a technical support staff, the technical support center being in communication with the network device through a packet switching network. The network device includes

5   one or more hardware subsystems, one or more software subsystems and means for monitoring the status of the hardware and software subsystems so that when a problem occurs with respect to one or more of the hardware and software subsystems of the network device, the network device for transmitting a first message to the technical support center to notify the technical support center of the problem, wherein the technical support staff is able to diagnose

10   the problem without interruption to the operation of the network device.

Fig. 1

Network

18

16

14

25

Email/Page
Subsystem

24

Remote Diagnostic
Embedded Process
Subsystem

28

38

32

Hardware
HEALTH
STATUS
MONITOR
SUBSYSTEM

46

HW Device

HW Device
...

34

Memory
Monitoring
Subsystem

26

40

44

42

Software
HEALTH
Status
Monitor
Subsystem

30

48

SW Subsystem

SW Subsystem
...

36

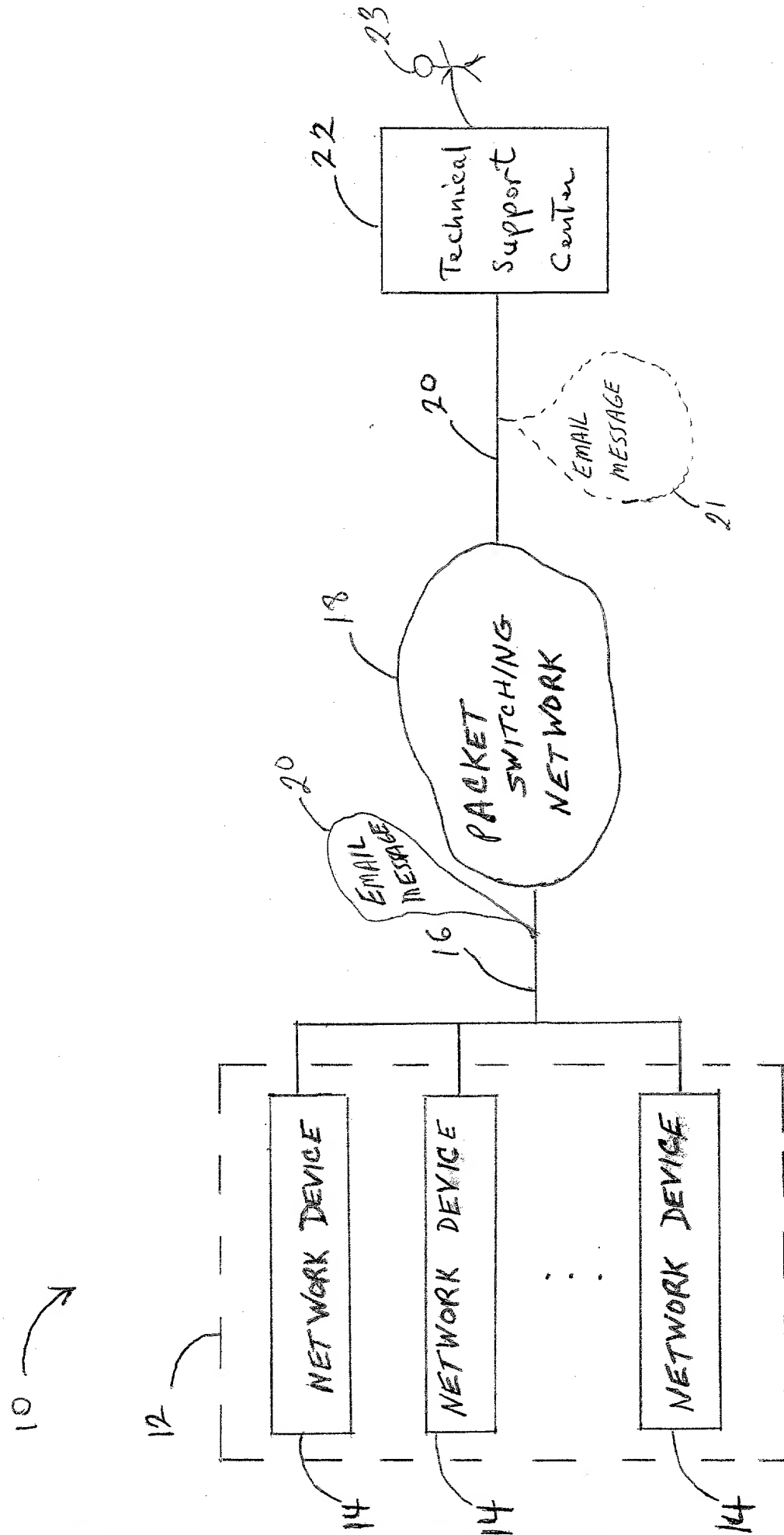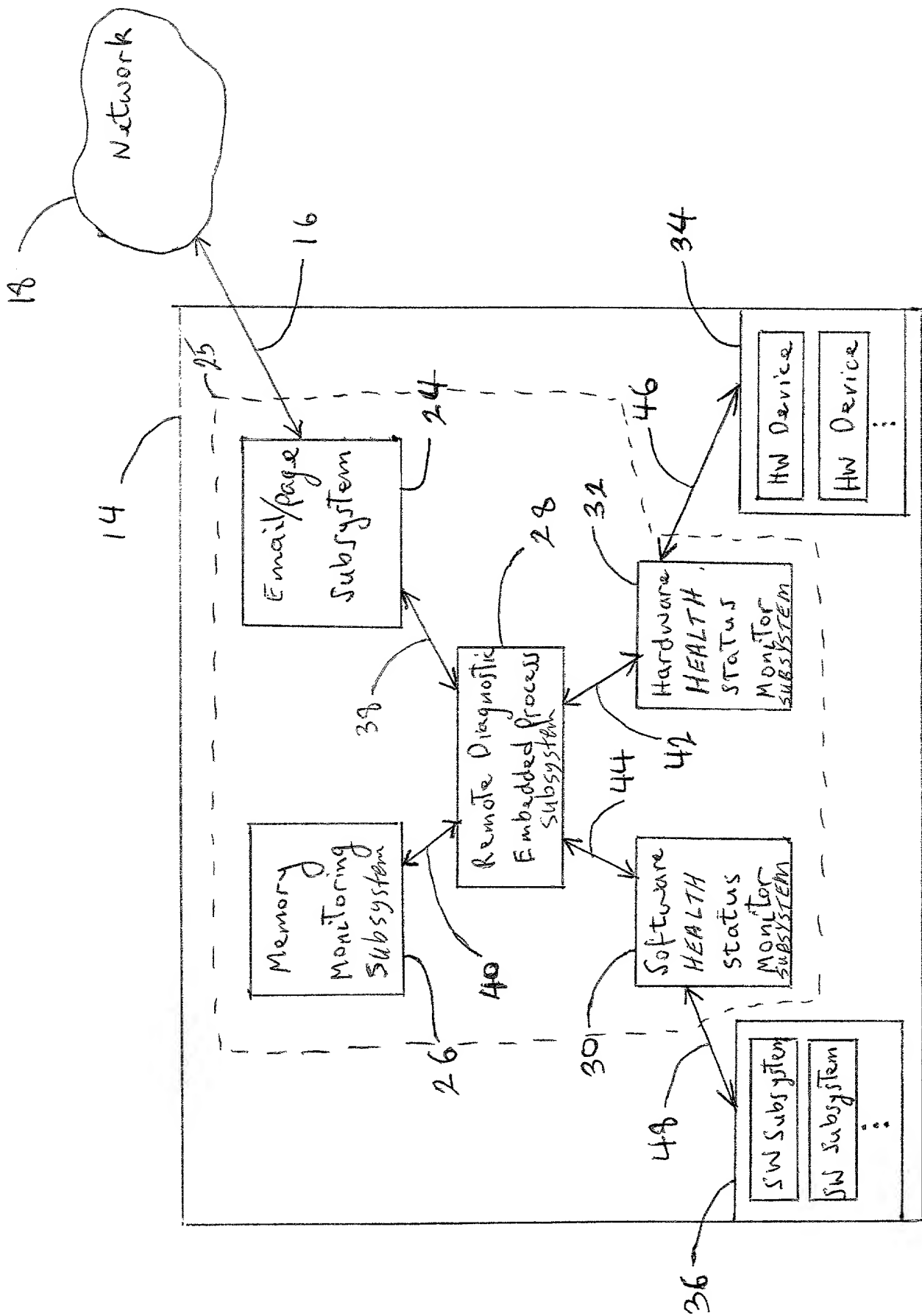Fig. 2

Central Process Software Architecture

Fig. 3

Bug CSCdp64343   Enclosure 4 of 10
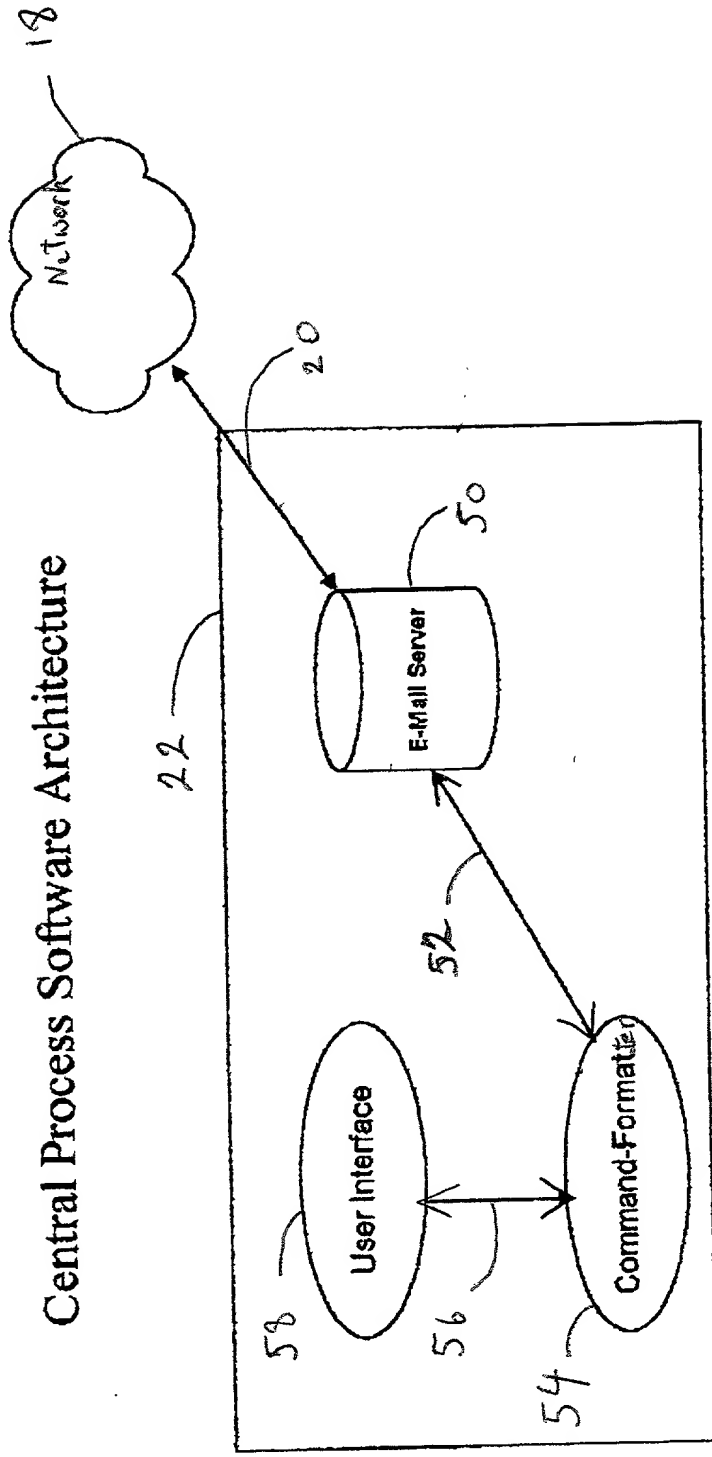   Added 000107 by hanif
CSC.sys
all

```
1
2
3   rommon 7 > stack
4   Kernel Level Stack Trace:
5   Initial SP = 0x616cbd48, Initial PC = 0x602dce94, RA = 0x602dce94
6   Frame 0 : FP= 0x616cbd48, PC= 0x602dce94,     0 bytes
7   Frame 1 : FP= 0x616cbd48, PC= 0x602c92e4,    24 bytes
8   Frame 2 : FP= 0x616cbd60, PC= 0x602d8fd8,    40 bytes
9   Frame 3 : FP= 0x616cbd88, PC= 0x602d91b8,   200 bytes
10  Frame 4 : FP= 0x616cbe50, PC= 0x602d87f8,    40 bytes
11  Frame 5 : FP= 0x616cbe78, PC= 0x602b68c0,   168 bytes
12  Frame 6 : FP= 0x616cbf20, PC= 0x602b5aec,    32 bytes
13  Frame 7 : FP= 0x616cbf40, PC= 0x602db848,    88 bytes
14  Process Level Stack Trace:
15  Initial SP = 0x630fac40, Initial PC = 0x603f6080, RA = 0x603f608c
16  Frame 0 : FP= 0x630fac40, PC= 0x603f068c,    56 bytes
17  Frame 1 : FP= 0x630fac78, PC= 0x603f068c,    72 bytes
18  Frame 2 : FP= 0x630facc0, PC= 0x602b39e4,    24 bytes
19  Frame 3 : FP= 0x630facd8, PC= 0x602b39d0,    24 bytes
20  rommon 8 > context
21  Kernel Level Context:
```

Kernel Level Context

Reg	MSW	LSW	Reg	MSW	LSW
zero	00000000	00000000	s0	00000000	34000001
AT	00000000	61730000	s1	00000000	00000001
v0	00000000	0000000a	s2	00000000	0000000a
v1	00000000	00000010	s3	00000000	00000010
a0	00000000	0000002b	s4	00000000	618dd470
a1	00000000	0000000a	s5	00000000	61250000
a2	00000000	00000010	s6	00000000	618f0000
a3	00000000	618dd470	s7	00000000	618e8e20
t0	00000000	00000038	t8	00000000	0009990d
t1	00000000	34000001	t9	00000000	00000000
t2	00000000	10001082	k0	00000000	618dd470
t3	ffffffff	ffff00ff	k1	00000000	6173ecc0
t4	00000000	00001000	gp	00000000	616cbd48
t5	00000000	0000001c	sp	00000000	00000000
t6	ffffffff	ffff00ff	s8	00000000	602c92e4
t7	00000000	00000002	ra	00000000	602dc060
HI	00000000	00000006	LO	01000020	
EPC	00000000	602dce94	ErrPC	10001082	
Stat	34000002		Cause		
Interrupt Control Register					

```
44  Process Level Context:
```

Process Level Context

Reg	MSW	LSW	Reg	MSW	LSW
zero	00000000	00000000	s0	00000000	0d0d0d0d
AT	00000000	618e0000	s1	00000000	0d0d0d0d
v0	00000000	0be6d67d	s2	00000000	64b06ec
v1	00000000	00000000	s3	00000000	618e5b78
a0	00000000	01263690	s4	00000000	618e8b78
a1	00000000	00000000	s5	00000000	61250000
a2	00000000	00000000	s6	00000000	618f0000
a3	00000000	00000003	s7	00000000	618e8e20
t0	00000000	00000001	t8	00000000	602d9ff4
t1	00000000	00000001	t9	00000000	00000000
t2	ffffffff	ffff00ff	k0	00000000	30400c01
t3	ffffffff	00001f00	k1	00000000	00000000
t4	00000000	0000f36d	gp	00000000	6173ecc0
t5	00000000		sp	00000000	630fac40
t6	00000000	01000000	s8	00000000	00000000
t7	01000100	0000000f	ra	00000000	603f608c
HI	00000000	00000000	LO	00000000	00000000
EPC	3400ff03	603f6080	ErrPC	00000000	602dc060
Stat	3400ff03		Cause	01000010	
Interrupt Control Register				10001182	

```
67  rommon 9 >
68  hanif@life:NONE:symbols[84] rsym c5400-js-mz.symbols Jan7
69  Reading c5400-js-mz.symbols.Jan7
70  c5400-js-mz.symbols.Jan7 read in
71  Enter hex value: 603F6080 603F068C 602B39E4 602B39D0
72  0x603F6080:cdp_cache_ager(0x603f602c)+0x54
73  0x603F068C:cdp_prot(0x603f03f4)+0x298
74  0x602B39E4:r4k_process_dispatch(0x602b39d0)+0x14
75  0x602B39D0:r4k_process_dispatch(0x602b39d0)+0x0
76  Enter hex value:
77  Enter hex value:
78  Enter hex value:
79  Enter hex value: 0x602dce94
80  0x602dce94:emt_call(0x602dce90)+0x4
81  Enter hex value: 0x602dce94
82  0x602dce94:emt_call(0x602dce90)+0x4
83  Enter hex value: 0x602c92e4
84  0x602c92e4:mon_cpu_exception(0x602c92c0)+0x24
85  Enter hex value: 0x602d8fd8
86  0x602d8fd8:r4k_return_to_monitor_direct(0x602d8f60)+0x78
87  Enter hex value: 0x602d91b8
88  0x602d91b8:r4k_return_to_monitor(0x602d9010)+0x1a8
89  Enter hex value: 0x602d87f8
90  0x602d87f8:handle_exception(0x602d84d0)+0x328
91  Enter hex value: 0x602b68c0
92  0x602b68c0:special_default(0x602b66a4)+0x21c
93  Enter hex value: 0x602b5aec
94  0x602b5aec:r4k_signal_handler(0x602b59a8)+0x144
95  Enter hex value: 0x602db848
96  0x602db848:r4k_sig_dispatch_return(0x602db848)+0x0
97  Enter hex value: 0x603f6080
98  0x603f6080:cdp_cache_ager(0x603f602c)+0x54
99  Enter hex value: 0x603f068c,
100 0x603f068c,:cdp_prot(0x603f03f4)+0x298
101 Enter hex value: 0x602b39e4
102 0x602b39e4:r4k_process_dispatch(0x602b39d0)+0x14
103 Enter hex value: 0x602b39d0
104 0x602b39d0:r4k_process_dispatch(0x602b39d0)+0x0
105 Enter hex value:
```

60

Fig. 4

Fig. 5

Device Driver N (i.e. Modem) — 72

Device Driver B (i.e. Hard-disk Controller) — 70

Device Driver A (i.e. Ethernet) — 68

Hardware HEALTH Status Monitor Subsystem — 74

hardware status

Software Subsystem N (i.e. Netscape) — 66

Software Subsystem B (i.e. User interface)

Software Subsystem A (i.e. IP protocol) — 64

software status

Software HEALTH Status Monitor Subsystem — 76

Memory Monitor Subsystem — 78

memory status

Collect/Compute/Update System Status — 80

System status

Determine System Status — 82

Require to send a notification ? — 84

Date to format an Email /Page

NO

Yes

Format an Email/Fax/Page — 86

Email/FAX/Page to be sent

Send to /Email/Page subsystem — 88

Electronic data is sent to network

PACKET SWITCHING Network — 90

62

Data arrives from the packet switching network

Packet switching Network

Email/Page subsystem — 94

Parse/Interprete the arrival commands — 96

Save Arrival Info — 98

Determine Actions — 100

Send a command to a software subsystem — 104

Send a command to a hardware subsystem — 106

92

Software Subsystem A — 108

Software Subsystem B — 110

Software Subsystem C — 112

Hardware Subsystem A

Hardware Subsystem B — 116

Hardware Subsystem C — 118

Software Health Status Monitor subsystem — 114

Hardware Health Status Monitor subsystem — 120

Collect/Combine/Update System Status — 122

124

Send a report — 102

Format an Email/Fax/Page — 126

Email/FAX/Page to be sent

Send to Email/Page subsystem — 128

Electronic data is sent to network

PACKET SWITCHING Network — 130

Fig. 6

DECLARATION, POWER OF ATTORNEY AND PETITION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled "DIAGNOSTIC/REMOTE MONITORING BY EMAIL" the specification of which

         ☒ is attached hereto

         ☐ was filed on_____ as Application Serial No._____

         and was amended on _____ *(if applicable)*.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) or U.S. provisional application(s) for patent or inventor's certificate listed below and have also identified below any foreign application or U.S. provisional application(s) for patent or inventor's certificate having a filing date before that of the application of which priority is claimed.

Prior Foreign/U.S. Provisional Application(s)

			Priority Claimed	
(Number)	(Country)	(Day, month, year filed)	Yes	No
(Number)	(Country)	(Day, month, year filed)	Yes	No
(Number)	(Country)	(Day, month, year filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, § 1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Serial No.)	Filing Date	(Status: Patented, pending, abandoned)
(Application Serial No.)	Filing Date	(Status: Patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint MARYAM IMAM Reg. 38,190 of IMAM & ASSOCIATES, Two North Second St., Suite 1100, San Jose, CA 95113 (408) 271-8752, as my attorneys with full power of substitution and revocation, to prosecute said application and to transact in connection therewith all business in the Patent and Trademark Office and before competent International Authorities.

Docket No.: 14013-33US   – 1 –

Address all telephone calls to Maryam Imam at (408) 271-8752 and address all correspondence to:

Maryam Imam, Esq.
IMAM & ASSOCIATES
Two North Second St., Suite 1100
San Jose, California 95113

Wherefore I pray that Letters Patent be granted to me for the invention or discovery described and claimed in the foregoing specification and claims, and I hereby subscribe my name to the foregoing specification and claims, declaration, power of attorney, and this petition.

Full Name of Sole Inventor: John Dung-Quang Ly

Home Address: 131 Meadowland Drive, Milpitas, CA 95135-4416

Post Office Address: Same as above

Citizenship: United States of America

Inventor's Signature: _____   Date: 03/06/2000